

WHAT IS CLAIMED IS:

1. A temperature control system for a semiconductor processing facility comprising:
 - 5 a cooling unit for controlling the temperature of a cooling fluid; and
 - a plurality of remote temperature control modules in fluid communication with said cooling unit, each of said remote temperature control modules including:
 - 10 a cooling fluid circulation loop for circulating said cooling fluid through said remote temperature control module, said cooling fluid circulation loop being in fluid communication with said cooling unit;
 - a heat transfer fluid circulation loop for circulating a heat transfer fluid through said remote temperature control module, said heat transfer fluid being in fluid communication with a process component of said semiconductor processing facility;
 - 15 means for exchanging heat between said cooling fluid that is circulated in said cooling fluid circulation loop and said heat transfer fluid that is circulated in said heat transfer fluid circulation loop;
 - a cooling fluid control valve for controlling the circulation of said cooling fluid through said cooling fluid circulation loop; and
 - 20 temperature control logic for controlling said cooling fluid control valve in response to temperature set point information and temperature feedback information related to said process component.
- 25 2. The temperature control system of claim 1 wherein each of said remote temperature control modules includes a heat source in thermal communication with said heat transfer fluid for providing heat to said heat transfer fluid.

3. The temperature control system of claim 2 wherein said heat source is controlled by said temperature control logic in response to said temperature set point information and temperature feedback information related to said process component.

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4. The temperature control system of claim 3 wherein said heat source is integrated with said means for exchanging heat.

10 5. The temperature control system of claim 4 wherein said means for exchanging heat includes a heat exchanger that integrates a portion of said cooling fluid circulation loop, a portion of said heat transfer fluid circulation loop, and said heat source.

15 6. The temperature control system of claim 1 wherein said cooling unit is physically separate from said plurality of remote temperature control modules.

7. The temperature control system of claim 6 wherein said cooling unit is located in a utility basement of said semiconductor processing facility.

20 8. The temperature control system of claim 7 wherein said plurality of remote temperature control modules are located in a subfloor area of said semiconductor processing facility.

25 9. The temperature control system of claim 7 wherein said plurality of remote temperature control modules are physically connected to process tools within said semiconductor processing facility.

30 10. The temperature control system of claim 1 wherein said cooling unit is set to maintain said cooling fluid at a temperature that is related to the lowest set point temperature among all of said process components that are thermally influenced by said cooling fluid.

11. The temperature control system of claim 1 wherein said cooling unit is a refrigeration unit that provides compressed refrigerant to said plurality of remote temperature control modules.

5 12. The temperature control system of claim 11 wherein:

 said cooling fluid circulation loop is a refrigerant circulation loop for circulating refrigerant through said remote temperature control module;

 said cooling fluid control valve is a thermal expansion valve for controlling the circulation of said refrigerant through said refrigerant circulation loop; and

10 further including a flow control valve for controlling the circulation of said refrigerant through said refrigerant circulation loop, said flow control valve being downstream from said thermal expansion valve.

13. The temperature control valve of claim 12 wherein each of said remote

15 temperature control modules includes a heat source in thermal communication with said heat transfer fluid for providing heat to said heat transfer fluid.

14. A temperature control system for a process component of a semiconductor processing facility comprising:

a remote temperature control module, said remote temperature control module including:

5 a cooling fluid input for receiving cooling fluid from a cooling unit that serves multiple remote temperature control modules;

a cooling fluid output for returning cooling fluid to said cooling unit that serves multiple remote temperature control modules;

10 a cooling fluid circulation loop for circulating said cooling fluid through said remote temperature control module;

a heat transfer fluid input for receiving heat transfer fluid from said process component;

15 a heat transfer fluid output for returning said heat transfer fluid to said process component;

a heat transfer fluid circulation loop for circulating said heat transfer fluid through said remote temperature control module, said heat transfer fluid being in fluid communication with said process component of said semiconductor processing facility;

20 means for exchanging heat between said cooling fluid that is circulated in said cooling fluid circulation loop and said heat transfer fluid that is circulated in said heat transfer fluid circulation loop;

a cooling fluid control valve for controlling the circulation of said cooling fluid through said cooling fluid circulation loop; and

25 temperature control logic for controlling said cooling fluid control valve in response to temperature set point information and temperature feedback information related to said process component.

15. The temperature control system of claim 14 wherein said remote temperature control module includes a heat source in thermal communication with said heat transfer fluid for providing heat to said heat transfer fluid.

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16. The temperature control system of claim 15 wherein said heat source is controlled by said temperature control logic in response to said temperature set point information and said temperature feedback information related to said process component.

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17. The temperature control system of claim 16 wherein said heat source is integrated with said means for exchanging heat.

10 18. The temperature control system of claim 17 wherein said means for exchanging heat includes a heat exchanger that integrates a portion of said cooling fluid circulation loop, a portion of said heat transfer fluid circulation loop, and said heat source.

15 19. The temperature control system of claim 11 wherein said cooling unit is physically separate from said remote temperature control module and said multiple remote temperature control modules.

20 20. The temperature control system of claim 14 wherein said cooling unit is located in a utility basement of said semiconductor processing facility.

25 21. The temperature control system of claim 19 wherein said remote temperature control module is located in a subfloor area of said semiconductor processing facility.

22. The temperature control system of claim 19 wherein said remote temperature control module is physically connected to a process tool within said semiconductor processing facility.

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23. The temperature control system of claim 14 wherein said cooling unit is set to maintain said cooling fluid at a temperature related to the lowest set point temperature among all remote temperature control modules that are served by said cooling unit.

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24. The temperature control system of claim 14 wherein:

 said cooling fluid input is a refrigerant input for receiving compressed refrigerant from a refrigeration unit that serves multiple remote temperature control modules;

10 said cooling fluid output is a refrigerant output for returning expanded refrigerant to said refrigeration unit that serves multiple remote temperature control modules;

 said cooling fluid circulation loop is a refrigerant circulation loop for circulating refrigerant through said remote temperature control modules;

15 said cooling fluid control valve is a thermal expansion valve for controlling the circulation of said refrigerant through said refrigerant circulation loop; and

 further including a flow control valve for controlling the circulation of said refrigerant through said refrigerant circulation loop, said flow control valve being downstream from said thermal expansion valve.

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25. A temperature control system for a process component of a semiconductor processing facility comprising:

5 a remote temperature control module, said remote temperature control module including;

a cooling fluid input for receiving cooling fluid from a physically separate cooling unit that serves multiple remote temperature control modules;

10 a cooling fluid output for returning cooling fluid to said cooling unit that serves multiple remote temperature control modules;

a cooling fluid circulation loop for circulating said cooling fluid through said remote temperature control module;

15 a heat transfer fluid input for receiving heat transfer fluid from said process component;

a heat transfer fluid output for returning said heat transfer fluid to said process component;

20 a heat transfer fluid circulation loop for circulating said heat transfer fluid through said remote temperature control module, said heat transfer fluid being in fluid communication with said process component of said semiconductor processing facility, wherein said cooling fluid circulation loop and said heat transfer fluid circulation loop are separate fluid distribution systems;

a heat source in thermal communication with said heat transfer fluid for providing heat to said heat transfer fluid;

25 a heat exchanger for exchanging heat between said cooling fluid that is circulated in said cooling fluid circulation loop and said heat transfer fluid that is circulated in said heat transfer fluid circulation loop;

a cooling fluid control valve for controlling the circulation of said cooling fluid through said cooling fluid circulation loop; and

30 temperature control logic for controlling said cooling fluid control valve and said heat source in response to temperature set point

information and temperature feedback information related to said process component.

26. The temperature control system of claim 25 wherein said heat source is
5 integrated with said heat exchanger.

27. The temperature control system of claim 25 wherein said cooling unit is located in a utility basement of said semiconductor processing facility.

10 28. The temperature control system of claim 27 wherein said remote temperature control module is located in a subfloor area of said semiconductor processing facility.

15 29. The temperature control system of claim 25 wherein said cooling unit is set to maintain said cooling fluid at a temperature related to the lowest set point temperature among all remote temperature control modules that are served by said cooling unit.

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30. The temperature control system of claim 25 wherein:

 said cooling fluid input is a refrigerant input for receiving compressed refrigerant from a refrigeration unit that serves multiple remote temperature control modules;

5 said cooling fluid output is a refrigerant output for returning expanded refrigerant to said refrigeration unit that serves multiple remote temperature control modules;

 said cooling fluid circulation loop is a refrigerant circulation loop for circulating refrigerant through said remote temperature control modules;

10 said cooling fluid control valve is a thermal expansion valve for controlling the circulation of said refrigerant through said refrigerant circulation loop; and

 further including a flow control valve for controlling the circulation of said refrigerant through said refrigerant circulation loop, said flow control valve being downstream from said thermal expansion valve.

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31. A temperature control system for a semiconductor processing facility comprising:

a refrigeration unit for providing a compressed refrigerant; and

a plurality of remote temperature control modules in fluid communication

5 with said refrigeration unit, each of said remote temperature control modules including;

a refrigerant circulation loop for circulating said refrigerant through said remote temperature control module, said refrigerant circulation loop being in fluid communication with said refrigeration unit;

10 a heat transfer fluid circulation loop for circulating a heat transfer fluid through said remote temperature control module, said heat transfer fluid being in fluid communication with a process component of said semiconductor processing facility;

15 a thermal expansion valve for controlling the circulation of said refrigerant through said refrigerant circulation loop;

a flow control valve for controlling the circulation of said refrigerant through said refrigerant circulation loop, said flow control valve being downstream from said thermal expansion valve;

20 a heat exchanger for exchanging heat between said refrigerant that is circulated in said cooling fluid circulation loop and said heat transfer fluid that is circulated in said heat transfer fluid circulation loop; and

temperature control logic for controlling said cooling fluid control valve in response to temperature set point information and temperature feedback information related to said process component.

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32. The temperature control system of claim 31 wherein each of said remote temperature control modules includes a heat source in thermal communication with said heat transfer fluid for providing heat to said heat transfer fluid.

33. A temperature control system for a process component of a semiconductor processing facility comprising:

a remote temperature control module, said remote temperature control module including;

5 a refrigerant input for receiving compressed refrigerant from a refrigeration unit that serves multiple remote temperature control modules;

a refrigerant output for returning expanded refrigerant to said refrigeration unit that serves multiple remote temperature control modules;

10 a refrigerant circulation loop for circulating said refrigerant through said remote temperature control module;

a heat transfer fluid input for receiving heat transfer fluid from said process component;

15 a heat transfer fluid output for returning said heat transfer fluid to said process component;

a heat transfer fluid circulation loop for circulating said heat transfer fluid through said remote temperature control module, said heat transfer fluid being in fluid communication with said process component of said semiconductor processing facility;

20 a thermal expansion valve for controlling the circulation of said refrigerant through said refrigerant circulation loop;

a flow control valve for controlling the circulation of said refrigerant through said refrigerant circulation loop, said flow control valve being downstream from said thermal expansion valve;

25 a heat exchanger for exchanging heat between said refrigerant that is circulated in said refrigerant circulation loop and said heat transfer fluid that is circulated in said heat transfer fluid circulation loop; and

temperature control logic for controlling said cooling fluid control valve in response to temperature set point information and temperature feedback information related to said process component.

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34. The temperature control system of claim 33 wherein said remote temperature control module includes a heat source in thermal communication with said heat transfer fluid for providing heat to said heat transfer fluid.